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AUTHOR Ridge, H. Laurence
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ABSTRACT

A usual reaction both from those teaching multiculturalism and those teaching mathematics has been that neither subject has a place with the other. With compassion and effort, both generalists and mathematics teachers can enhance multicultural and mathematical studies. Whether with a homogeneous group representing an indigenous culture, or with a multiethnic class, teachers can boost students' image of self and cultural background by relating math problems in contexts familiar to their culture. Illustrative examples from sports, dwellings, and native foods are suitable ways of employing cultural diversity in lessons. Considering brain bimodality when teaching visualization of algorithms is also relevant. Including the mathematical aspects of cultures in social studies and history can serve to develop appreciation of these cultures and of the internationally rich heritage that is mathematics. It is up to individual teachers to include and emphasize multicultural concepts and to remove the "we don't do it that way here" attitude from the classroom. (Author/KR)

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A TWO-WAY STREET

Multiculturalism in Mathematics and Mathematics in Multiculturalism

Presented at

The First Congress on Education

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By H. Laurence Ridge

Faculty of Education,
University of Toronto

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A Two-Way Street:

Multiculturalism in Mathematics and Mathematics in Multiculturalism.

H. Laurence Ridge.[1]

Whether it is the responsiblity of teachers of multicultural programs to become more conversant with the mathematics associated with various cultures or it is the responsiblity of those teaching mathematics to become more aware of suitable multicultural contexts within which to teach the subject is a moot point. It is a matter of all parties cooperating by lending their expertise to either direction. It is the purpose of this exposition to examine both considerations as well as addressing some related points of concern in the teaching of mathematics.

The all too typical reaction of mathematics teachers to any mention of multiculturalism and mathematics refers to the universality of mathematics:

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1. Special thanks are due to Dr. Mavis Burke of the Ontario Ministry of Education and Dr. Keith McLeod of the Faculty of Education, University of Toronto for inspiring this article. Excellent cooperation was provided by Mrs. Kathy Whetter of the Department of Indian Affairs, Mr. Basil Johnson of the Royal Ontario Museum and Mr. Allan Waters of Forest Hill Collegiate Institute.

the fact that "in Karachi, Nicosia, Bradford and Hong Kong the angles of a triangle add up to 180 degrees (Gill & Gill, 1977)" or that "y = 2x + 3 looks the same and has the same meaning in every country of the world (Ridge, 1977)".

Admittedly, if the subject could be treated in schools at strictly an abstract level there would be little concern. However, pedagogical need for meaning dictates that concepts be explained through youngsters' experience or environment[1]. It is in this regard that considerable attention should; indeed, must, be paid to the cultural background of the learner. Language differences may indicate cultural diversity but such recognition is only peripheral. One intent of this paper is to outline for those engaged in teaching mathematics to culturally diverse groups some areas of concern requiring thoughtful consideration along with some suggestions for possibly more effective treatments.

Let's be frank at the outset however, that unless a teacher has developed an appropriate mind

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1. Zaslavsky (1975) tells of a Chilean metallurgical worker coming to realize the significance of the '5 times table' "40 years after he had dutifully memorized his multiplication facts" (p. 232) through application of a 1:5 ratio on a blue print.

set in the matter; that is, has recognized some need to reach certain youngsters and is open to suggestions as to how to alleviate the situation, there is little point in bombarding such a person with all that follows.

Relating to indigenous cultures:

In an article dealing with the mathematics education of Indian children in Arizona, several cogent points are made which may well have implications for multicultural education anywhere (Smith and Bitter, 1974). The fact that American Indians have succeeded better in the educational system than a number of other minorities is attributed to their being permitted to retain much of their own identity and culture. Teachers and their aids are encouraged to note the characteristics of Indian people, and to make every attempt to understand and accommodate the Indian point of view[1].

In private conversation, Basil Johnson, a teacher of the Ojibwe language and presently with the

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1. "For example, there is some indication that a white teacher's normal tone of voice is considered too loud by American Indian children who sometimes interpret it as indicating anger or meanness (Grove, 1977, p.25)".

Royal Ontario Museum claims that one of the most pressing needs and areas open to research and development in the education of Canadian Indian children is a creation of mathematical materials which relate to the children's own culture. An analogous situation has occurred in Africa where, generally speaking, the school programs do not integrate indigenous cultures into the curriculum, but rather use African editions of European or North American materials[1]. Lewis (1975) reported that the greatest initial accomplishment of the implementation of mathematics work cards designed to reflect African culture (in Botswana, Lesotho, and Swaziland) was the marked improvement of student attitude toward mathematics.

> "Apparently trivial perhaps, but very meaningful to the pupils: one young girl who found a card with her African name on it was so excited that she took it into the next room to show her friends who were still using foreign textbooks" (p. 20).

In relating his classroom experiences with minority students in Ontario Schools Mills (1978) told of bringing about general attitude change in a

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1. This policy accrues largely from the belief of African leaders that their people and nations will remain underdeveloped if they do not aspire to the cultures of 'more advanced societies'.

Pakistani student by discussing with the student some of the high points of recent travel to that country. That a non-Asian would hold the country of the student's heritage in high esteem would surely be a contributing factor to growth in his self esteem.

Multiculturalism as sound pedagogy:

Whether with a homogeneous group representing an indigenous culture or with a multi-ethnic class, the matters of attitude and the affective domain relative to the cognitive domain in mathematics learning are underscored by classroom teachers[1.] as being critical. A student's poor image of self or cultural background is often felt to be the basis of low achievement in mathematics[2.] and general ineptitude within our educational system.[3.] Anything which can be done to help improve that image by playing up

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1. The educational research literature in this area is not nearly so supportive of this position.

2. We must be aware also that the educational systems in some countries are more elitist and as a result produce students whose mathematical acumen is far in advance of their Canadian peers. Even though such students may have initial language difficulties they should not be forced into mathematics programs commersurate with their ability in English.

3. Apparent deterioration of minority student standing in comparison with others, is often a statistical fallacy rather than an educational fact. As students' ages increase so does the variance in their scores. Although raw scores may diminish, it is the z-scores (in terms of standard deviations) which are significant.

individual interests[1]. cannot help but be a plus. In the case of minority youngsters this may well take the form of spotlighting aspects of their respective cultures both historical and current as being particularly significant (as cited in the earlier Mills reference). Hence multiculturalism in this sense becomes basically an application of sound pedagogy. The 'catch 22' here, of course, is that most teachers must go out of their way to learn something of the cultures represented by their students and this calls for an additional teacher commitment.

Relating to brain bimodality:

Another aspect of sound pedagogy in Mathematics Education involves consideration of the currently popular brain bimodality theory.

> "A recent synthesis of existing evidence on the functioning of the human brain, together with new findings, indicates that the two hemispheres of the cerebral cortex process stimuli differently. For most right-handed persons, the left hemisphere treates stimuli serially, one at a time, whereas the right hemisphere processes stimuli many at a time as a gestalt. This functional difference

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1. Professor Frank DuPont at the Faculty of Education, University of Ottawa tells of building the interest of a class of low achieving youngsters on the basis of accidentally finding out that three of the students were Sea Cadets. Relating to this interest carried beyond those individuals to stimulate the whole class.

> renders each hemisphere superior in performing certain types of tasks; the left hemisphere is better at such tasks as reading, speaking, analytical reasoning, and arithmetic, and the right hemisphere is better at spatial tasks, recognizing faces, and music. (Wheatley et al, 1978, p. 20)"

Some authors (Harkin and Rising, 1978) are urging mathematics teachers to pay more attention to this phenomena[1]. in the teaching of mathematics especially in matters of visualization of algorithms. They point out that the mathematics which has been traditionally taught in the elementary schools has been left-hemisphere oriented (as has been 'schooling' generally). Wheatley (1978) argues that problem solving ability could be enhanced through more attention to right-hemisphere development. Such problem solving attributes as integration and analysis; holistic, relational, and divergent thinking; and creativity and intuition are associated with the right-hemisphere.

The particular relevance of this concept to multicultural considerations was stressed by

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1. Such opinion is not unanimous among psychologists. Goleman (1978) points out the fadism aspect of split brain theory and urges caution in jumping on the bandwagon.

Marshall McLuhan in a recent presentation[1]. He argued that cultures of industrialized nations were more left-hemisphere oriented while those of emerging (or 'third world') countries tended towards the right-hemisphere[2]. Certainly the predominantly left-hemisphere nature of the school system could not help but relegate many minority children to the ranks of low achievers[3]. It should be noted that it is environmental contigencies which are credited for stimulation of one hemisphere or the other. There is no suggestion whatever of genetic descendency.

Relevant Contexts:

One of the current emphases in mathematics methodology is the presentation of concepts within contexts relevant to students. In the case of groups

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1. Address to the "Television's Child" Conference, Ontario Teacher Education College, Toronto, October 1977.

2. The same conclusion applied to the culturally and academically deprived in our own society but not necessarily for the same reasons.

3. Some psychological studies have concluded that the linguistic dialects of some particular sub-cultures can deal only with ideas of relatively low sophistication. Other researchers have negated such findings by working with similar subjects strictly in terms of their own vernacular and within a natural environment.

of youngsters with various ethnic backgrounds, teachers cannot assume that contexts familiar to North American children will convey the same meaning, or indeed any meaning, to individuals brought up in other cultures. Burns (1978) tells of a Jamaican student of rural background who was foundering in arithmetic largely because of the irrelevance of the examples (space travel and surprisingly, apple pie) which the teacher cited for illustrative purposes. If we would reflect on the fact that perhaps not all cultures use cutlery to the extent that North Americans do, we may realize that the straight line (cut) may not be nearly so significant and that if 'bread'[1.] is broken apart, the notion of 'fraction' may not be nearly so well defined as in the case of accurately sliced pies. Another assumption of universal ubiquity is the notion of right angle. Recall the African work card (cited in the Lewis Article) which featured the circular hut typical of local dwellings. How much importance would be placed in right angles in such a structure?

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1. "Bread" as we think of it is virtually unknown to many African people because of a lack of leavening.

The general difficulty in finding realistic applications of interest[1] to all students in a class and being able to separate student interests from those of (adult) teachers presents a perennial problem. Johnson and Rising (1975) suggest that what might be more appropriate are more zany characterizations of situations which do not pretend to be real, but which, nevertheless, have an intrinsic appeal to youngsters. Puzzle style contexts can provide such material.

In this vein, a pictorial approach to algebraic expressions has been used by W. W. Sawyer (1964) with 'bags' (8) of an unknown number of stones. At a later stage of development the 'bag' can be converted by cutting off top and bottom to a symbol (X) which looks like and is replaced by the

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1. Mills (1978) suggests
"In trigonometry, for example, instead of calculating the height of trees from their shadow and angle of elevation, problems could involve the C.N. Tower, the height of the Taj Mahal, and the angle at the base of the leaning tower of Pisa. A problem involving a boat going from Toronto to Centre Island could be presented along with a problem of a 'walla-walla' (water taxi) going from Hong Kong Island to Kowloon (p. 5,6)".

standard 'x'. Sawyer also employs pictorial imagery in setting up pairs of simultaneous linear equations in terms of height of 'men' and 'sons'. Both are cases of imagery to which youngsters of any culture could relate.

Multiculturalism in deference to all:

So far this paper has dealt with the teaching of mathematics so as to make it more meaningful

a. to homogeneous groups of a given culture,
b. to students representing minority cultures in classes of mixed ethnic background, and
c. to any students in the sense that techniques cited for cases a. and b. were merely applications of sound pedagogy in different circumstances[1].

Even the psychology of improving self-image remains constant.

There is, however, quite another side to mathematics teachers' employing cultural diversity in their lessons. There is little doubt that historical references to the Hindu-Arabic numerals

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1. This argument is somewhat akin to Rising's admonition that there is no such thing as special methodology for less able students in mathematics. It is simply a matter of teachers' exercising their best methodology more often.

or to the Hindu origin of the word 'algebra' (Gill & Gill, 1977) could stir some excitement among children of East Indian background just as reference to the accomplishments of Fibonacci might arouse youngsters of Italian descent. With some explanation the name Benjamin Banneker,[1.] could be a source of pride for Black children (Mulcrone, 1976). The passage of centuries does not seem to diminish the significance for youngsters, perhaps because of their lack of development of a sense of historical perspective. Although Gill & Gill (1977) imply that such references be selected in deference to the particular cultures represented in a given mathematics class, it would seem more educationally sound (and certainly less smacking of tokenism) to employ such references wherever pertinent in order to enlighten all students of the contributions of as many cultures and individuals in the development of mathematics, not only to strengthen multicultural tolerance and appreciation but also to inculcate in students' minds the notion of the development of mathematics as 'a human endeavour'[2.]

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1. Benjamin Banneker is considered to be a pioneer among Black mathematicians in the United States. Mills (1978) used one of his problems expressed in poetic form as a classroom activity.

2. In recognition of Harold Jacob's unique and excellent book Mathematics, A Human Endeavour, San Francisco: Freeman Publishing Co., 1971.

and so a reflection of the development of civilization. Schaaf (1978) has presented a concise and stimulating history of mathematics as portrayed by the postage stamps of nations around the world. This treatment, while downplaying nationalistic fervour, does credit cultures and individuals; and as well by implication, indicates those countries which have recognized international mathematical accomplishments through commemorative postage stamps. Regretfully, Canada is represented only once and that in recognition of computer technology.

Integrated studies and multicultural mathematics:

As a further attempt to develop appreciation of various cultures, and to include mathematics within integrated studies wherever feasible teachers should be encouraged to have their students deal with mathematical aspects of cultures with which they are dealing. This is expecially so in conjunction with African studies and Canadian Indians. In both cases there are popular misconceptions about the lack of mathematical prowess in these cultures. Zaslavsky has done much to dispel the myths regarding the African scene in her many publications both in terms of Arithmetic, geometric and topological activities.

Although there is a great need for research into mathematical aspects of historical Canadian Indian culture, there is evidence that gambling games flourished and hence that the concept of probability was involved. Through the Department of Indian affairs and the Ojibwe Cultural Foundation, Mary Lou Fox has published materials involving number and geometric design (as practised by Ojibwe people) suitable for classroom implementation. Keller (1972) has designed discovery exercises which relate to ancient numeration systems. His idea is excellent because it encourages pattern recognition within numeration systems (involving different symbols) and forces consideration of advantageous facets of the Hindu-Arabic numeration system with which Canadian youngsters are familiar. Such discovery exercises could well be designed using Swahili, Ojibwe or any other linguistic or symbolic basis. The so-called "nickel and dime" system of the Kpelle people of Liberia (Zaslavsky, 1976) provides particularly rich material. Teachers and students alike stand to gain both a mathematical and crosscultural pay off.

With reference to number and counting, nothing could be more topical than the use of fingers. This

situation has been occasioned by the recent North American television coverage of 'chisanbop', a computational system developed in Korea which is closely related to the abacus but depends solely on the action of the fingers. Of course its use in schools is highly controversial because of North American adversity to the use of fingers as a computational crutch. Historically and culturally however, the use of various systems of finger computation is well documented. Zaslavsky cites a preponderance of such finger use among African peoples occasioned by the need for communication in the market place made difficult by the wide diversity of languages and dialects even within a relatively small geographical region. Parts of the body besides fingers have been used by native peoples in Papua and New Guinea (Wolfers, 1971) as well as in Africa (Zaslavsky, 1976 a).

There is a system of finger multiplication common to areas of eastern Europe which dates back to Roman times (Alger, 1968). Explaining how the system works provides a useful investigation of pattern within our number system and requires some algebraic manipulation if the validity of the method is to be 'proved'.

Origami - the art of paper folding (without need of scissors or paste) - is quite a popular school activity within study of Japanese culture. Very rarely, however, is it exploited from a mathematical, or more specifically, a geometric point of view. Such a book of paper folding is available from the National Council of Teachers of Mathematics (Olson, 1975). From a somewhat more advanced viewpoint Pedersen (1976) has investigated an extension of origami to the folding of three-dimensional geometric figures.

Unlike the rich heritage of mathematics which has come to Western culture through the Egyptians, Greeks, Moslems, Hindus, and Islamic peoples, until recently there has been little appreciation of ancient Chinese mathematics. Swetz (1972, 1976, 1977) has done much to bring to the attention of mathematics teachers the profundity of mathematics with which the Chinese were familiar, in many cases apparently prior to development of the same or analogous concepts or techniques in India, the near East or Europe. Study of some of these techniques (especially related to the Pythagorean Relation) could certainly enhance student understanding.

Another aspect of integrated study in which mathematics plays a significant role lies in games and sports. The african game of Kalah is popular in

North America both as a commercial and educational game involving number and strategy. Some consideration of the history and cultural significance of the game (Zaslavsky, 1976) would serve the dual purpose of enhancing appreciation of the game and of gaining further insights into African culture. The game has such deep historical roots throughout Africa that anthropologists have studied variations in its play among peoples of African descent living in various parts of the Caribbean and South America to help ascertain those parts of Africa from which their forefathers came.

In seeking out interests among minority students in his classes, Mills (1978) found that soccer and cricket were favourite sports of West Indian youngsters (as participants or spectators). One of the investigations he devised concerned features of soccer such as the amount of leeway (size of the angle) available to a kicker from various points on the field in order to have the ball arrive between the goal posts. A second more extensive effort (appropriately titled "Home Runs and Sixes") led students to make useful comparisons between baseball and cricket so that everyone in the class became more familiar with both games through basic

mathematical analysis (such as cross-sectional area of the respective bats, speed of the ball, and resulting relative ease of hitting a "pitch" or a "ball". Another activity ("Caught on the Boundary or Dropped by the Bleachers") investigated the relative ease of being "caught out" in the two games through a comparison of areas of the playing fields and of a baseball glove as opposed to a bare hand. Where a teacher has the expertise and access to the necessary equipment, actual instruction in the fundamentals of cricket (perhaps as an elective or extra curricular activity) would make such investigations even more meaningful.

Multiculturalism in Mathematics Textbooks:

A review of most of the elementary and secondary level mathematics textbooks published in Ontario found relatively littel evidence of multiculturalism. However, one secondary level series originally published in 1970 which features many photographs of young people as extrinsic motivation was metricated in 1975. In the second edition the photographs were also revised so that about 50% were representative of minority groups in comparison to a virtual "null set" in the earlier version.

Some texts give token recognition to non-Anglo-Saxon names within problem contexts. Very few include realistic problem contexts of a multicultural nature. Notable exceptions are consideration of geometrical aspects of postage stamps (size, shape, geometric design) representing different countries and exercises involving unusual weights and measures associated with various countries (prior to metrication and, of course, helping to justify world-wide metrication).

Secondary level texts generally include interesting and useful segments of the history of mathematics but even then in a few cases the national or cultural background is downplayed.

In summary

The onus once more falls on individual teachers to enhance multicultural studies with inclusion of mathematical considerations and to place more emphasis on multicultural contexts from which some mathematical concepts can be drawn. The extensive list of reference at the end of this article may help provide some ideas. Even more can be generated through conversation and correspondence with students and others whose backgrounds represent diverse cultures.

Because different algorithms (ways of carrying out mathematical calculations) are often taught in different countries, students newly arrived in Canada can serve to enrich our mathematics programs by showing their methods and having the teacher and class try to ascertain how and why they work; that is, understanding rather than criticism. All of us just may learn something. Such a practice demands reversal of the all too prevalent "we don't do it that way here" attitude. One basic case in point involves subtraction with regrouping ('carrying' if you must).

STANDARD ALGORITHM	$\begin{array}{r} {}^{6}\cancel{7}\,{}^{1}\cancel{3} \\ -\,4\,9 \\ \hline 2\,4 \end{array}$	ALTERNATIVE ALGORITHM	$\begin{array}{r} {}^{1}\cancel{7}\,\cancel{3} \\ -\,{}^{5}\cancel{4}\,\cancel{9} \\ \hline 2\,4 \end{array}$

European countries and those jurisdictions using British mathematics programs would opt for the alternative algorithm rather than the standard form so familiar to Canadian school children. Why do the two algorithms result in the same answer? How would you explain?

As a closing thought the following quotation most aptly expresses the sentiment underlying this article.

"We [in North America] are grateful to the British for many innovations in mathematics education, among which I range at the top their "Maths with everything" approach. All the peoples of the world have develcped mathematics to the extent that their societies require. Our children will miss a great deal if we fail to extend the 'maths with everything' concept to the study of other cultures. (Zaslavsky, 1975, p. 13)"

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